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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/942,004	08/29/2001	Raoul Florent	FR 000089	9021

24737 7590 10/14/2004

PHILIPS INTELLECTUAL PROPERTY & STANDARDS
P.O. BOX 3001
BRIARCLIFF MANOR, NY 10510

EXAMINER	
KRONENTHAL, CRAIG W	
ART UNIT	**PAPER NUMBER**
2623	

DATE MAILED: 10/14/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No.	Applicant(s)	
	09/942,004	FLORENT ET AL.	
	Examiner	Art Unit	
	Craig W Kronenthal	2623	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 August 2001*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-14* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) *1-14* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *29 August 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. ______.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *5/6/02, 8/29/01*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

Claim Objections

1. Claims 1-12 are objected to because of the following informalities:
   - On the last line of claim 1, constraints CZt and θ should be explicitly recited if these symbols are to be disclosed in claim 1.

Appropriate correction is required.

2. Claim 1 is objected to because of the following informalities:
   - On the last line of claim 1, "(C2t)" should be replaced by (CZt).

Appropriate correction is required.

3. Claim 3 is objected to because of the following informalities:
   - On the fourth line of claim 3, the upper case T in "(Gt-2, GT-1)" should be replaced by a lower case t resulting in (Gt-2, Gt-1).

Appropriate correction is required.

4. Claim 4 is objected to because of the following informalities:
   - On line 1 of the claim, "The method of one of claim 1" should be replaced with "The method of claim 1".
   - On lines 3 and 5 of the claim, "(CZt)" should not follow "Search Zone" since this abbreviation corresponds to the Canal Zone. It does not appear that the search zone is intended to be limited as being canal-shaped in this claim.

Appropriate correction is required.

5. Claim 8 is objected to because of the following informalities:
   - On line 3 of the claim, in order for "or spheres" to be considered the parentheses containing the words must be removed.

Appropriate correction is required.

6. Claim 11 is objected to because of the following informalities:
   - On line 2 of the claim, "prediction phase (30)" should be replaced with "prediction phase (20)"

Appropriate correction is required.

7. Claim 14 is objected to because of the following informalities:
   - On line 1 of the claim, "A computer program product comprising" should be replaced with "A computer program embodied in a computer readable medium comprising". The terminology "computer program product" alone has no set definition.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claim 1 is rejected under 35 U.S.C. 102(b) as being anticipated by Corby, Jr. (P.N. 5,253,169). (hereinafter Corby)

Regarding Claim 1: Corby discloses an image processing method for extracting a threadlike structure represented in an image, comprising:

- A phase of acquisition of a sequence of images, including an image of a present instant (t) in which the threadlike structure is to be extracted and an image of a past instant (t-1) in which the threadlike structure is detected as a string of points, (col. 4 lines 31-36). A detection screen (Fig. 1, 104) captures frames of a threadlike structure, specifically the outline of a catheter, representing multiple instances of time. The digitizer and frame store (Fig. 1, 112) receives the frames and converts the images into a string of points.

  further comprising:

  - A phase of prediction of a silhouette of the threadlike structure estimated form said detected string of points, of the image of the past instant (col. 5 lines 7-8). The phase of prediction is the peak finding algorithm (300) shown in Figure 3. This algorithm is a part of the temporal sequence image analyzer (TSIA) (Fig. 1, 114). The peak finding algorithm (300)

outputs a binary image showing the guide wire pixels, corresponding to a silhouette of a threadlike structure (col. 4 line 67 – col. 5 line 6).

- A phase of pursuit for extracting a final string of points representing the threadlike structure in the image of the present instant t, including steps of estimation of constraints based on said silhouette for performing said extraction (col. 4 lines 27-28). The two-dimensional model creation module (500) shown in Figure 5 acts as the phase of pursuit. This phase of pursuit (500) inputs the guide wire pixels from the phase of prediction (200) and outputs a 2D guide wire model.

Regarding Claim 2: Corby discloses the method of claim 1, wherein in the prediction phase, the silhouette is formed of the string of points detected in the image of the past instant (t-1). The digitizer and frame store (112) digitizes each frame, including that of a past instant (t-1), which is then sent to the TSIA (Fig. 1, 114). The peak finding module (Fig. 3, 300) inputs a digitized image of a past instant and outputs a binary image containing guide wire pixels, which are a string of pixels forming a silhouette (col. 5 lines 43-45).

Regarding Claim 3: Corby discloses the method of claim 1, wherein:

- The acquisition phase comprises a first image of a first past instant (t-2) and a second subsequent image of a second past instant (t-1), in which the threadlike structure is detected as respective first and second strings of points (col. 4 lines

31-36). A detection screen (Fig. 1, 104) captures frames of a threadlike structure, specifically the outline of a catheter, representing multiple instances of time. The digitizer and frame store (Fig. 1, 112) receives the frames and converts the images into a string of points.

- And the prediction phase comprises the calculation of a translation value and speed of translation between the first and second strings of points, and the calculation of a translation value to occur between the second past instant (t-1) and the present instant (t) for estimating the location of the silhouette in the image of the present instant (t) (col. 5 line 10-24). The temporal sequence image analyzer (TSIA) (Fig. 1, 114) calculates the maximum gradient, which is used as a translation value. The TSIA also calculates the maximum second derivative, which is used as a value of translation speed. The TSIA predicts the location and orientation of the threadlike structure, or catheter, utilizing the information obtained from analyzing several frames at previous times (col. 4 lines 39-42).

Regarding Claim 4: Corby discloses the method of one of claim 1, wherein in the pursuit phase, the steps of estimation of constraints comprises the estimation of Search-Zone in the image of the present instant (t) around the silhouette for a constrained extraction of the final string of points in said Search Zone (col. 7 lines 13-21). As depicted in Figure 9, the two larger circles represent search regions surrounding the silhouette or guide wire pixels, such as pixel P. The search regions are

used to limit the area searched so that the guide wire points are connected forming a final continuous silhouette.

Regarding Claim 5: Corby discloses the method of claim 4, wherein the Search-Zone is a Canal-Shaped Zone labeled Canal Zone, centered on said silhouette (col. 7 lines 13-27). The circular search regions surround each pixel belonging to the silhouette thereby forming a canal shape.

Regarding Claim 6: Corby discloses the method of claim 4, wherein the steps of estimation of constraints comprises the estimation of an interval of directions associated to the points of the Search-Zone (col. 8 lines 24-26). The curvature minimization module (Fig. 6, 836) is the part of the pursuit phase that computes the sum of the difference in angle between adjacent chains. This difference in angle between adjacent chains is an estimation of an interval of directions. In addition these angle differences are associated with points located on the silhouette within the search region.

Regarding Claim 7: Corby discloses the method of claim 6, wherein a neighborhood is estimated for each given point of the Search Zone so that said neighborhood intersects the silhouette and determines a segment (col. 6 lines 16-22) and wherein the directions of the silhouette are determined at each point of said segment, forming a set of directions, which set of directions determines the interval of directions for a constrained extraction of the final string of the points that are associated to an interval of directions

(col. 8 line 17-27). Corby explains that the eight neighbors of each "on" pixel, that is a point within the search region, are searched and a segment is determined by finding those neighbors that are also "on" pixels. The segment therefore consists of three pixels one adjacent to another. Furthermore, Corby teaches the obtaining of direction vectors at points on the segment for determining the interval of directions by calculating the difference in angles between one direction vector and another.

Regarding Claim 8: Corby discloses the method of claim 7 wherein the Search Zone is a canal-shaped zone labeled canal zone estimated by an operation of mathematical morphological dilation using discs of a predetermined radius around the silhouette, (col. 7 lines 23-27) and wherein the extraction of a string of points is performed in said Canal Zone by ridgeness estimation along the directions of the interval of direction associated to each point and the final string of points is selected from the points having the highest ridgeness (col. 5 lines 19-25). Corby actually defines two search regions for a guide wire pixel. Both of which are circular in shape and given a predefined radius. Figure 2a shows a possible embodiment of the spatial beam modulator, which uses the canal zone to focus the radiation on only parts of the image where the catheter is located. Figure 2a shows how the canal zone is made from morphological dilation of the individual circular search regions. Furthermore, Corby explains how the extraction of guide wire points is performed on every pixel within the canal zone, through the calculation of gradients and assigning those pixels, in the direction from which the maximum value was discovered, the maximum value calculated. The result is a peak

image, which selects those points having the highest ridgeness for the final string of points.

Regarding Claim 9: Corby discloses the method of claim 1, further comprising, in the pursuit phase, steps of tip evaluation for determining whether the tip of the extracted string of points is correctly located for representing the threadlike structure in the image of the present instant (col. 9 lines 4-10). The temporal sequence image analyzer (TSIA) (Fig. 1, 114), which houses both the prediction phase and pursuit phase, locates the tip of the catheter and sends a signal to the modulator indicating the position. It is understood that the TSIA (114) would not send this signal if the catheter could not be located and therefore the system would switch to a full field of view (col. 9 lines 19-22).

Regarding Claim 10: Corby discloses the method of claim 9, further comprising in the pursuit phase, steps of shape correlation for estimating the correct location of a final tip for the final string of points representing the threadlike structure (col. 3 lines 60-66). The modulator (Fig. 1, 108), although a separate unit is considered along with the TSIA (Fig. 1, 114) as part of the pursuit phase, is responsible for performing the step of shape correlation.

Regarding Claim 11: Corby discloses the method of claim 1, having a loop (4) between the pursuit phase and the prediction phase for improving the detection of the silhouette and the extraction of the string of points for representing the threadlike structure in the

image of the present instant (t) (col. 5 lines 55-58). The loop (Fig. 6, 630) returns the optimal guide wire path outputted by curvature minimization module (Fig. 6, 636) belonging to the pursuit phase to the tree to the tree building module (Fig. 6, 632) belonging to the prediction phase.

Regarding Claim 12: Corby discloses a system comprising a suitably programmed computer or a special purpose processor having circuit means, which are arranged to process image data according to the method as claimed in claim 1 (col. 4 lines 36-39). Corby discloses that the TSIA (Fig. 1, 114) is a computer programmed to perform the method of claim 1 as previously described.

Regarding Claim 13: Corby discloses a medical examination imaging apparatus having means for acquiring medical digital image data and having a system having access to said medical digital image data according to claim 12, and having display means for displaying the medical digital images and the processed medical digital images (col. 3 lines 50-53). The medical imaging apparatus (Fig. 1) utilizes a detection screen (Fig. 1, 104) as an acquisition means for obtaining x-ray images and a video monitor (Fig. 1, 122) for displaying the output.

Regarding Claim 14: Corby discloses a computer program product comprising a set of instructions for carrying out a method as claimed in claim 1 (col. 4 lines 36-39). The TSIA (Fig.1, 114), which embodies both the prediction and pursuit phases is a computer

programmed equipped with the necessary steps (Figs. 3 and 6) to carry out the method described in claim 1.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

- Zarge et al. (PN 5,289,373) is cited for teaching a medical image processing apparatus with similar prediction and pursuit phases for real-time tracking of threadlike structures.
- Chang et al. (PN 5,999,651) is cited for teaching the prediction and pursuit phases for the purpose of image tracking.
- Oe (PN 5,056,524) is cited for teaching the use of temporal images to obtain a silhouette for locating a catheter with a vascular system.
- Sambonsugi et al. (PN 6,335,985) is cited for teaching an object extraction apparatus for detecting the position of a target object and tracking a moving object.
- Otsuka et al. (PN 6,263,089) is cited for teaching a method and equipment for acquiring a motion trajectory of an image contour of a target.
- Sun et al. (PN 6,480,615) is cited for teaching an improved optical flow method of deriving motion estimation within a sequence of data frames.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Craig W Kronenthal whose telephone number is (703) 305-8696. The examiner can normally be reached on 8:00 am - 5:00 pm / Mon. - Fri..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amelia Au can be reached on (703) 306-6604. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

CWK
10/04/04

MEHRDAD DASTOURI
PRIMARY EXAMINER

Mehrdad Dastouri